COLORADO PLATEAU RAPID ECOREGIONAL ASSESSMENT (REA)
Workshop 5 Summary
Salt Lake City, Utah
September 22 and 23, 2011

Thursday, September 22, 2011

Introductions

Verlin Smith provided welcomes and led group introductions. He then introduced *Carmen Bailey*, Utah Division of Wildlife Resources, to report on the progress of the Western Governors' Association.

Carmen: Western governors agreed to do wildlife corridor mapping across 19 western states and to produce a decision support tool. *Carmen* noted that wildlife agencies do things very differently among the various states, but they hope to share data and produce complementary products. Within the four states that *Carmen* monitors, California and Arizona have the best data; Utah does not have a centralized database. She feels that Utah and Nevada won't have a decision support tool by 2013. She is hoping that data from the REAs will supplement the data they have been collecting and organizing for the WGA project.

Jim Strittholt Presentation

Jim Strittholt of Conservation Biology Institute (CBI, Dynamac subcontractor) presented the results of several months of GIS analysis. He began the presentation by saying that he wanted to steer the discussion during the workshop toward meaningful issues rather than merely presenting a data parade (which would be easy to do with the huge quantity of material that has been produced). *Jim* went on to explain the review process on Data Basin in more detail; he also offered to help workshop participants load their own data to compare it to results on Data Basin.

Karl Ford noted that under the Supporting Documents tab, one would find a spreadsheet of all of the management questions and the status of the results that have been posted to Data Basin.

Jim listed the main components of the REA: conservation elements, change agents, and management questions. He also described other important REA components that are not addressed directly by management questions, such as conservation element status, predicted future conditions, an index of ecological integrity, and the identification of opportunities and constraints on the landscape. He showed examples of other tools for organizing information: conceptual models created for each conservation element, process models that explain the steps in developing map products, and logic models used to organize the thinking of the more complex multi-tiered models.

Jim showed an example of an attribute and indicator table that was developed for each conservation element. Although many indicators may be collected for individual conservation elements and placed on a gradient from poor to very good, only a small subset of these indicators will have appropriate spatial data to use in the REAs at the ecoregional scale.

Current and Future Development Management Questions

MQ G1 Where are the current locations of these development types?

Jim recalled the Environmental Monitoring Decision Support Tool (EMDS) that was proposed for use at Workshop 3. Although BLM decided against the use of EMDS, CBI decided to rebuild EMDS in

ModelBuilder and Python because its use of logic models and fuzzy logic make the complex rollup of components of the ecological integrity model easier for participants and reviewers to understand. This analog of EMDS will be easier to run, though it will lack some useful elements of EMDS.

Jim showed the logic model for the first development questions, MQ G1. Source inputs, intermediate results, and final results are color coded in the logic model and these colors are repeated in the results to help the viewer follow the process. He explained the use of fuzzy logic. We control the logic in various ways by:

- controlling the break points or thresholds. Regardless of the source data or units used, everything is put into a true/false question and put on a -1 to +1 gradient. Fuzzy logic allows consideration of shades of gray. Jim illustrates a linear function and a step function. He uses wolf sensitivity to increasing road density as an example for a quantitative indicator that can be used in a model such as this.
- controlling the location in the logic tree. Elements that you want to have greater influence are put higher in the logic tree.
- the use of logic operators *sum, or* (pick the maximum), or *union* (average)
- and the use of weighting. One can weight the components equally, change the weighting, put in new data sources or new future scenarios, and rerun the model. The weights for the various components of the development model were urban development, 40; agriculture, 20; energy development 30; and recreation, 10. Jim pointed out that all of the components started out with equal weights in the first run, and weights were added and tested in subsequent runs. Weighting can be modified and different weights tested at any point. Although weighting is subjective, it helps to capture the elements of changes agents working synergistically.

Karl Ford: During a development webinar several weeks ago, the weightings were altered after group discussion of the weighting of intensive agriculture and livestock grazing. Livestock density information is not available, nor was information about how allotments were used annually or seasonally.
Jim: We don't have grazing information on private lands or Indian reservations either. We are trying to discriminate effects in the best possible way. The map is only as good as the data we put in. If I had herd density, it would make this model more useful. We were not given information on grazing. Recreation was also a problem, tracking types and intensity. The recreation data was mixed—dots, polygons, and lines; the roads data was not attributed to identify paved, unpaved, on road or off road travel.

Jim shows the process model for the high development piece, the intermediate results for the high urban, agriculture, energy and mining, and recreation components, and the final composite map for current development. He explains that viewing the results on Data Basin allows more exploration than is possible with a paper product with the ability to zoom in at various resolutions and to investigate individual component data layers.

Verlin Smith: We are reporting at the 5th level HUC. That doesn't mean that every part of that HUC is high development. *Jim*: Correct. Jim went on to explain the breaks in the legend. Minus one would be very low development and +1 very high development; however, because the last operators called for averaging (union), the maximum is less than +1. He also emphasized the difference between absolute and relative values (these are relative values pertaining to this place).

Betsy Herrmann: Do you take into account that the HUCs are different sizes? *Jim*: Yes, the results are density values or % area.

Dennis Zackman: Can we go back to weighting? How is weighting controlled? At what point is there a limit? *Jim*: The program asks you what weighting you want. We will go by what the group wants. You take the initial un-weighted results and refine them. He refers back to the original logic model: this is

today, with the data we have today. You can game different futures and run it again, say, asking will renewable energy become a bigger part of the picture?

Dennis adds to the group: I want to say that Jim is very responsive, if you have a problem or a question with Data Basin. *Karl*: Jim has done various webinars on some of these topics. *Karl* invited other workshop participants to join the Data Basin group.

Verlin: We are monitoring on an annual basis. In the future we may want to revise the weights. *Jim*: The strength of the logic models is flexibility, but that is also their disadvantage, meaning that users have to be careful in applying weights.

Jim went on to show examples of the different appearance of the results in the two main reporting units: 5th level HUC and 4 km grid. He expressed his opinion that the 4 km results showed more detail and better represented condition, especially in areas of some relief where more intact landscapes tend to be in the headwaters; in such cases HUCs tend to cancel out the distinctions by averaging condition across elevational changes in vegetation and habitat. There was general agreement.

Mark Miller: How does the model handle missing data? *Jim*: EMDS notes missing data and will warn when enough is missing to lose confidence in the results.

MQG2 Where are areas of potential future development?

For the 2025 projection, Jim showed the High Development logic model with several items added to represent potential future development: a bit of renewable energy potential, additional mining information (possible uranium mining), and David Theobald's urban growth projections. One could also add utility and pipeline data. There are scattered expansion areas; the results map shows darker areas where urban expansion is predicted.

Karl points out the uranium expansion area. *Sheila Williams* asks if the final report will give them the weightings that were used. Yes.

Jim shows several slides of current and future development side by side, HUC and 4 km results.

Invasive Species Management Questions

MQ F1 Where are areas dominated by cheatgrass?

Doug Havlina: Define invasive species. *Karl:* In our early discussions, we directed contractors to concentrate on a couple of invasive species. The two invasive species selected for this REA were cheatgrass and tamarisk. There will be opportunities to discuss something like pinyon-juniper invasion when we discuss Ecological Systems or climate change.

Jim shows a slide of fire-human activities-invasive plants interactions. *Jim*: This is a rapid assessment. We would like to deal with the synergies, but we can't delve into it too deeply. He goes on to show the process model for cheatgrass and all of the data sources: LANDFIRE EVT, cheatgrass occurrence points from SWEMP07, and a cheatgrass map developed by USGS for this REA (Terry Arundel).

Jim: Carmen brought up earlier the difficulty of meshing data from multiple states. The best we can do is go with what we believe is the best data we have and to note the efficiencies and inconsistencies, trying to make it as uniform as possible. He switches to Data Basin and explains Amazon Cloud: datasets are like books on a shelf that are taken off the shelf when needed.

He shows the results maps for the current distribution of cheatgrass. The 4 km view seems most useful; it shows several concentrations of cheatgrass in the eastern portion of the ecoregion.

MQ F1 Where are areas dominated by tamarisk?

Jim: We had various data types for tamarisk: point, poly-line, and raster (potential distribution model, Jarnevich et al.) at 1 km resolution.

Karl: Is it worthwhile to have a conversation about the tamarisk beetle? Defoliation has been extensive, but the tamarisk will come back. *Lisa Bryant*: It is changing so rapidly that anything we do is dated. There are other sources available. The areas with beetle will have a higher possibility of restoration. There is some die-off after five or six years of defoliation. *Karl*: Is this a good enough treatment for our purposes (*meaning what we already have*)? *Lisa*: It would be good to have presence-absence. Russian knapweed comes in in the understory. The tamarisk coalition has point data. We could do presence-absence based on this year. They re-survey yearly and take GPS locations of distribution. It would help if we detect beetle several years in a row. You are going to find increases in '08 because of increased level of effort—'09, '10 will be a result of monitoring. Get more data for 2008–2010, or 2009–2011.

MQ F2 Where are the areas of potential future encroachment from this invasive species?

Brendan Ward (CBI): LANDFIRE succession class was used for prediction. It isn't a process-based model and it is not linked to disturbance. *Brendan* showed results maps of current invasive species distribution (the two species covered in this REA) and future encroachment. The future encroachment map does not show present plus additional invasion, but shows just the added increment.

Doug Havlina: What about STATSGO/SSURGO inputs? *Brendan:* We used STATSGO because SSURGO is not complete. EVT and satellite imagery for green-up signature was also used. But the impression we got in the Sonoran was that even our best estimate was a big underestimate.

Betsy Herrmann: What was it that showed so much expansion in the Uinta Basin? *Brendan*: There may have been more plots allotted to cheatgrass.

Wildfire Management Questions

MQ E1 Where are the areas that have been changed by wildfire between 1999 and 2009?

Brendan Ward went through the process model and listed the data sources for the fire question (yearly fire perimeters from GEOMAC). They also extracted yearly fire severities (low, medium, high) from LANDFIRE disturbance class. *Jim*: We've got data from 1999–2010 from two different sources. Where the time period overlaps there are slight differences where the two entities are mapped.

Doug Havlina: GEOMAC? *Brendan*: Yes, GEOMAC for fire perimeters. MTBS was used for severity, satellite-imagery based change analysis. The upshot is they didn't necessarily capture small fires, but have good representation of larger fires.

The results maps show 4 km and HUC results for areas burned 1999–2010 and a map of the fire perimeters by severity.

MQ E2 Where are the areas with potential to change from wildfire?

Brendan Ward: We used a predictive model for fire future. We did it because there was no data available. We used MaxEnt with lightning density data, distance to roads, urban areas, water plus a few climate predictors (e.g., average annual and summer temperature and precipitation) and the database of fire occurrence points. (He shows several slides of the process model and the MaxEnt input surfaces.) Four

different models were created: High Probability of Human-Caused Fires, High Probability of Large Human-Caused Fires (> 100 acres), High Probability of Natural Fires, and High Probability of Large Natural Fires (> 100 acres). The likelihood of fire occurrence was turned into a binary result and 15% of the data was used as validation data. They are independent models meaning that one view isn't necessarily a subset of the other.

Shawn Servoss: Does it distinguish between prescribed fires and wildfires? No. *Doug Havlina*: That will dilute the meaning of these results. We should be able to differentiate. *Brad Washa*: Fuels treatments are included in the database. *Brendan*: We will check that when we get back. We'll try to distinguish and not include prescribed fire.

Verlin Smith: From a management standpoint, we are looking for risks. We can control prescribed fire, but not natural or human-caused wildfire. *Brad Washa*: The edges: there shouldn't be such differentiations at the border of the ecoregion. *Brendan*: Fine-scale road networks are strongly related to the incidence of fire. *Chris Colton* notes that the yellow and red symbols on the map are covering each other. *Jim*: If you zoom in closer, you can see the road network underneath. In Data Basin you can filter it and show only one or the other.

Brendan shows results maps for each of the four models as well as combined results and model agreement. He states that this was trained on 30 years of historical data and does not necessarily indicate where fires will occur in the future. What isn't represented is the strong influence of invasives. Brendan shows the AUC tables and summary AUC values for each model. AUC is a measure of how well the model is predicting relative to the test data. *Jim*: The ones that drive the results are the top few: vegetation condition, annual precipitation, road distribution, and lightning. *Brendan:* There was a correlation between lightning areas and human-use areas. The climate data was historic data, site correlates over the period 1968–1999. *Jim*: Climate and vegetation conditions drive natural fires. *Brendan*: In early versions certain predictors came in very low and we dropped them. We included the location of invasives early on, but they were not useful and were dropped.

MQ E3 Where are the Fire Regime Condition Classifications?

Brendan: For this question we need to know what sorts of conditions are expected under reference condition and how far current vegetation has departed from reference condition and reference fire regimes. Is the site within the natural range of variability or is it out of whack? This is very difficult to do.

LANDFIRE uses state and transition models and the Vegetation Dynamics Development Tool (VDDT) to simulate historical reference conditions and current vegetation conditions (LANDFIRE EVT) for successional states. FRCC classes range from Class 1 (Fire regimes within or near historical range) to Class 2 (Fire regimes moderately altered) and Class 3 (Fire regimes significantly altered). *Brendan* showed the results maps for 4 km and HUC results with red areas indicating high departure.

Doug Havlina: No additions to the LANDFIRE results? *Brendan* says he knows that LANDFIRE has some problems. The next version of FRCC is due out soon. *Karl*: We need an interpretation of the red areas. *Karl and Chris Colton* are looking at the Kaiparowits area which is red. *Brendan*: That area was mapped as being invaded by cheatgrass. *Jim:* Areas that are red don't always mean it is burning more; it could be not burning enough.

Doug Havlina: This is a vegetation departure map based on reference states of vegetation. The question is: Is there the right proportion of seral stages that resemble the reference state? In the red watershed there is an imbalance. My concern is that 90% of our region is in Condition Class 2, moderately departed. Jim: Would you be happier with 5 classes? *Brendan*: LANDFIRE now has a 0–100 scale. This 3 class result answers the management question. We tried another method but it pushed it even more into the yellow.

Karl: What does it mean to a manager? Is it helpful at the ecoregional level? *Jimi Gragg*: Take the yellow areas that are closer to the red. Let us know where to go to pay most attention. *Karl*: Let CBI know if you want to talk about this more.

MQ E4 Where is fire adverse to ecological communities, features, and resources of concern?

Brendan shows the process model for question E4. Rare and frequent fire systems were extracted from LANDFIRE Fire Regime Condition Class and LANDFIRE succession class identified uncharacteristic native vegetation composition. LANDFIRE's uncharacteristic exotic vegetation plus the results from the invasive species questions represented the potential interaction between fire and invasives. Invasive vegetation plus uncharacteristic fire behavior acting on rare fire systems suggest areas where fire may be adverse to ecological communities.

Chris Colton pointed out an area near Parker Mountain with black sage. Brendan: Black sage is somewhere in the middle, 50–100 years. Frequent fire systems are the most messed up right now. Mixed fire frequencies are more difficult to determine. *Doug*: If you would rephrase it to pertain to sage grouse, you might get different results. *Chris*: You want to know something specific, not a general map. *Karl*: Good point. We are concerned here with the cumulative effects of threats. We might tweak the fire results to include sage grouse. *Jim*: We can have a generic model, but also modify for individual conservation elements. It can be done, but we need the details to make it work. We'll see how the intactness layer can be used for multiple applications.

Brendan: Where we know there is an adverse relationship between fire and a species, the map of likelihood of fire can show where a particular species is at risk. We can do some of that where needed.

<u>Potential Change in Fire Due to Climate Change</u>

Brendan notes that we can project into the future using the same models and predict for two time steps. One can compare the future prediction with the present and take a difference to denote potential change in high probability of fire occurrence. The two classes are *loss of high probability* and *gain of high probability*. The 4 km and HUC results maps displayed < -10% change through 0 to > 10% change in high probability of fire occurrence over the period of 2015–2030 based on the ECHAM5 climate change model.

Jim: Let's go back to the AUC charts. Climate variables are included here. We have the historic numbers and new future averages of these same variables and run the MaxEnt model again. Ideally what you would like is for every pixel to show the difference. But this is not showing that. This is based on high probability of fire occurrence. New areas are being added (in red) and other areas are taken away (in blue). This is not showing areas added to the previous extent. With long chronic averages, it is the point of variability that dictates the outcome. How likely is it to be volatile? These are large averaging windows.

Doug H.: What about vegetation? We are not factoring in invasives; vegetation trends don't relate to this. *Brendan*: We used MAPSS global scale vegetation classes. They were too coarse to use here. *Jim*: There are dynamic models that deal with this. In the Sonoran, there was a lot of blue. That is counterintuitive, but the thought, if there is little vegetation, there is not much to burn. The climate model MCI is more dynamic; it would be better for that. *Brendan*: This model deals with correlation with climate variables, not vegetation. We could use climatic stress on vegetation communities based on expert rules. Would that be better to use? *Doug*: We know where future management will be applied. *Karl*: We have the elements in the intactness layer. *Jim*: We came close to tossing the slides. We can leave this out.

Karl: One idea of the REA is to compile interactions between change agents and conservation elements. We have some new hypotheses. Is this real? We can put it in the report and say this is not high

confidence, an area of new research. We've asked the Dynamac team to attach a confidence level to the derived results. *Verlin*: It is interesting. We are trying to find how the change agents affect species, but here it is how one change agent affects another: climate change on fire. Where do you stop? I think this is interesting, but I'm not so sure of the immediate application of it.

Jim: This is a huge project. Each part creates more questions. We have a small window to advance some of these questions. We have expended more energy on using logic models and looking at integrity. The other main element was climate change as a change agent that affects other conservation elements and change agents.

LUNCH

Ecological Integrity

Jim: Producing a high development map was somewhat easier than producing the intactness surface.

Karl: The SOW required an index of ecological integrity. Such an index has almost never been applied at the ecoregion level. It is a stand-alone product at the HUC level for the ecoregion and it is applied to other issues.

Jim: An index by definition is not measuring everything. Of all the pieces that characterize an ecoregion, the difficult thing is to choose the most salient aspects. Indices of biotic integrity developed for aquatic systems are built on survey data and relative abundances. Though the concept has been applied terrestrially to a few taxa, at an ecoregion level it is new territory. We can't define integrity by the number of species; in a wilderness area one might find many fewer species than in more developed areas. The idea is to choose a few species to represent the full number of species: a guild of birds, a key pollinator, or a top predator. *Jim* shows the integrity logic model from Memo 3. He notes that we have spent the most energy on the landscape value arm of the logic model that represents species habitat. We can then interject biological information to tell us more.

Jim shows the more complex logic model where the objective is to map terrestrial landscape intactness. The four major components of landscape intactness are invasive species, permanent development, semi-permanent development, and natural habitat fragmentation, with weights of 10, 40, 25, and 25, respectively. Semi-permanent development is represented by mining, energy, and agriculture with the rationale that these disturbances can theoretically be mitigated or reclaimed in the future. *Jim* says the tendency is to put in too much to such a model. One has to winnow it down by looking for redundancies.

<u>Landscape Fragmentation</u>

Jim: For fragmentation analysis we used FRAGSTATS. FRAGSTATS runs metrics for the patch level, classes of patches, and the landscape level. This effort used class level metrics that are appropriate to the ecoregion scale. For the map of natural habitat fragmentation, the metrics were run on each class: natural, semi-natural, and other. Semi-natural included areas of invasives; the class *Other*, including water, development, and agriculture, was masked out. FRAGSTATS is not just an area game, but the spatial configuration of natural cover. The result can be rerun as changes occur in the future.

Jim showed the maps for fragmentation that include mean nearest neighbor distance, number of natural patches, and percent natural core area. Defining the edge of a patch constrains a core area. In this case the edge was buffered by 90 m. Core areas may be very different sizes and of varying utility depending on the shape of the initial patch. *Betsy*: % core area by HUC? Yes.

Jim showed the intermediate results for invasives, permanent and semi-permanent development, and FRAGSTATS. A union of the intermediate layers resulted in a final HUC results map of terrestrial intactness. The most intact areas were a darker green and the least intact areas light green.

Jim's question to participants: Do we use less weighting for semi-permanent development (as it is now 25 vs 40 for permanent development) or have it with weighting equal to permanent development? *Carmen Bailey*: We are trying to put wildlife crossings in for roads. Semi-permanent agriculture turns into housing. I tend to view both of those as equally influencing and should be classed with permanent development. *Jim*: We could leave the model as/is or weight them similarly and see what happens. *Betsy*: It depends on the time frame. A 25–50 year time frame for sage grouse is significant. That might decimate a local population even if the area is reclaimed. *Carmen*: Depending on your question, you can drill down and find out why a polygon is in a particular class. *Jim*: EMDS helps you out with that with a decision tool.

We looked at the 4 km intermediate results on Data Basin. *Jim* said that we are analyzing at 30 m and summarizing at 4 km. They could not do nearest neighbor/moving window analysis because the new version of ARC does not support FRAGSTATS. So the 4 km map is not acceptable and must be redone. As was pointed out earlier, Jim felt that the 4 km results give better information, because they represent topography and elevational changes better than the HUCs that tend to span elevational vegetation changes and average out the higher integrity areas in the headwaters. The 4 km version gives a more informative grain and the HUCs tend to muddy the signature.

Deciding on Thresholds or Breaks in Integrity Classes

Jim showed a slide of an EMDS truth values table. It is divided into 7 classes, from no support through full support, with an undetermined 0 value. Four breaks were suggested in the SOW, analogous to classes like poor, fair, good, and very good. *Jim* showed examples of three versions of the intactness results with three different legend class breaks: natural breaks, equal interval with four breaks, and EMDS breaks reduced to four classes from 7. *Jim* revised the 7 breaks to be -1 to 0, poor; 0 to .5 fair, .5 to .75 good, and .75 to 1 very good. His thinking was that if the scores were negative at all that then the area is not intact.

Carmen: I might want to use a different scale for different questions. *Jim*: The data will be provided. You can use it and display it graphically. *Carmen*: What would you recommend for those of us who make snap judgments? *Jim*: Pick one based on EMDS, but make sure it represents as close to reality as you think is reasonable and then standardize it. I think we need to tease out the negative end more and have five classes.

Tom Edwards: Are you going to store the raw data or put into bins? *Jim*: They will be able to do what they want with the raw data. *Verlin*: We're going to have tools available, but we need to know how to use it. *Carmen*: A county commissioner might look at it and say: there is too much intactness here or not enough. *Jim*: It will also be important to pick some good examples and then leave it with folks. We would like to get this to run live on Data Basin. *Karl*: How will you grade this classification? Rigid breaks or grade on a curve? Visualize protected areas overlaid. Four categories are not enough. On the EMDS legend there is too much territory in the lightest color; it needs more discrimination, but we should avoid good, fair, poor. *Matt Miller:* Adding one or more intervals. Do we need to put words to it? Why not have it be a number range. *Dennis*: If our legend was a little more descriptive like more intact, less intact, that would help.

Jim: Arranging the maps, condensing, taking out redundant maps to tell the story. We will find creative ways to put several maps on the same page, visual shorthand to see pattern and story. Jim continues to say that Tim of CBI will write a tutorial on the intactness roll-up. *Karl*: And Model Builder scripts will be delivered. *Jim*: We want to make it useful for those who are not GIS people.

Jim finishes this section by showing the intermediate and final results in the 4 km version. He also comments on the output for future terrestrial landscape intactness that has not been completed yet. He hopes to add fire disturbance and climate change impacts to the logic model for the prediction of future intactness.

Aquatic Intactness Model

Jim started the discussion of the aquatic intactness model by saying that he was not satisfied with it. The data is not complete enough to create a robust model. The logic model has five intermediate components that are averaged to create the model of aquatic intactness. The components and their weights are: Invasive species (10), Water Use (10), Water Quality (30), Land Use (25), and Aquatic Fragmentation (25). Invasive species data included tamarisk and aquatic invasives such as zebra and quagga mussels. The tamarisk data is fairly good, but the mollusk data is spotty. Water use data is at the county level and a little coarse. *Jim* asks if anyone knows of any datasets for water quality. *Lisa Bryant* asks if we are using just 303(d) or 305(b) polygons as well. *Scott Miller* suggests using their data. *Scott* and *Karl* both suggest that the model could use another box for ecological integrity.

Jim: Diversions and dams data could also be better. The smaller dams such as the pushup dams are not represented. *Scott*: There is a national inventory of dams, dams > 3 m high. *Justin Jimenez*: There is also a barriers dataset state by state. The Division of Water Rights has points of diversion (and likely also interbasin transfers). *Tom Edwards*: NRCS provides assistance to build installations for livestock use.

Jim: How do you interpret which species benefit? *Justin*: It would be on a case-by-case basis looking at an assessment of hydrologic alteration. *Scott*: Most of the hydrologic alteration is benefiting non-natives.

Justin: Can you explain the weighting on the top line? *Jim*: If you had to put a weighting on these, what would you say? *Justin*: Water use would rank one of the highest if not the highest. *Betsy*: What is water use? *Jim*: What is used by humans. *Justin*: Water use = water quantity. How has hydrologic function been altered? Here there was some discussion of changing the name of Water Use to Water Quantity.

Jim: Dams alter water quantity in a variety of ways. Should dams be separate or in the same box? Sometimes it is perfectly valid to count twice. *Justin*: Large dams should be weighted more.

Wildlife Species Conservation Elements

MQ D1 What is the most current distribution of available occupied habitat (and historic occupied habitat if available), seasonal and breeding habitat, and movement corridors (as applicable)?

Jim: We will concentrate on a handful of species and also look at status and restoration possibilities. Each species has its own issues.

<u>Mountain Lion</u>

Jim showed the process model and discussed data availability. For mountain lion, we had a modeled SW ReGAP distribution (wall to wall coverage) and individual state GAP maps (somewhat refined with gaps in the driest portions of the ecoregion). *Jim* reviewed the resolution from Workshops 3 and 4 that there were three ranked options for pursuing the species distribution questions: 1. Use existing state maps or models; 2. Create a model if there was sufficient occurrence data; and 3. Use SW ReGAP if nothing else was available. In this case, we have to use SW ReGAP (and/or state GAP). *Jim* shows the results and two reporting unit versions of the more refined mountain lion modeled distributions (state GAP).

Jim: They are everywhere. But maybe they ARE everywhere. *Carmen*: We generally map mountain lion habitat on top of deer habitat. *Karl*: This question came up in the Sonoran: Why not map where the deer

and sheep are? *Seth McClean*: It depends on what you are planning to do. We overlay with deer and try to get at density estimates for habitat types. *Jim*: The question here is, Where is current distribution? not Where are the highest densities? *Tom Edwards*: Dave Mattson, Flagstaff, has the most updated maps.

Tasha Carr: Given all these issues, what use is it to have mountain lion as a conservation element? *Jim*: Each species has issues. *Karl*: It becomes more informative when you overlay status (intactness) over the distribution map. *Jim* shows the attribute and indicator table for mountain lion. It's not that lions don't occur in developed areas; it's that they get into more trouble there.

Jim showed the mountain lion distribution plus the intactness layer overlaid (mountain lion status map). Lions are likely to do better in the high intactness areas (the darker green polygons). One could also overlay the distribution of mule deer or sheep. *Jim* noted that the one quantitative indicator in the table for mountain lion was one for a low road density threshold of .6 km/km^2 indicating poor conditions for mountain lion (Van Dyke et al. 1986). Again, this is an indication of where mountain lions will be stressed or run into trouble.

Golden Eagle

Golden eagle has a similar situation with a wall to wall SW ReGAP modeled distribution. The SW ReGAP model produces HUC and 4 km results that are very monochrome in appearance. *Jim* shows a slide of golden eagle occurrence data from Utah and GBIF (Global Biodiversity Information Facility). There is a concentration of data points in the northeast portion of the ecoregion. *Karl*: The original question is, Where are they? *Tom Edwards*: All this goes back to the intactness map. Here's the distribution, here are the stressors. There is no resolution to the problem of either biased point data (as we may have here) or wall-to-wall SW ReGAP data. *Seth:* We don't even manage golden eagle over its entire distribution, we manage nest sites.

Jim shows the eagle distribution together with the intactness layer. *Karl*: I made a quick calculation of all species for all REAs and golden eagle is on them all. As we move forward with wind energy, golden eagles become more important. *Jim* has prepared another overlay of eagle with potential (not permitted) wind development. The overlay indicates that very often, wind potential coincides with optimal eagle habitat.

Greater Sage Grouse

Jim shows the attribute and indicator table for Greater Sage Grouse. It is a good example of threshold information that may or may not be useful to an REA effort. On one hand, percent mean sagebrush canopy at nest sites is an indicator that does not lend itself to the ecoregional scale, but > 12 oil and gas wells per 4 km area is one that is applicable at the scale of an REA.

The intactness overlay shows that a large portion of the sage grouse distribution is already in the low intactness areas. *Karl*: With the sage grouse initiative, some states are expecting data from the REAs. They are required to consider all threats to the sage grouse. The REAs capture those threats. The intactness model addresses those threats. *Karl* thinks that the other contractors are doing a similar thing. *Verlin*: Overlaying sage grouse distribution with intactness paints a picture. We've been using it by overlaying development. I think the outcome will be useful. *Steve Madsen*: When we update our management plans, this information will be helpful.

Jim: We haven't added climate change to this yet. Where would we expect the vegetation to change and in what direction? It will give an indication of a likely trajectory. If I remember from the climate change results, up here (he points to the northern portion of the ecoregion) is on a trajectory for vegetation change. This overlay with intactness shows current condition; climate, future development, and fire are still missing. *Jim* overlays with a vegetation change map based on climate model ECHAM5 where

colored pixels note predictions for vegetation change in the future. *Karl*: The other thing we saw earlier was the fire prediction map.

The group then used Data Basin to zoom in on various areas in more detail and overlay protected areas. *Robin* notes that the Breeding Bird Density map shows 5.3 km around known leks, but that the blue areas that indicate this on the coverage are not all covered in sagebrush (using the Piceance Basin as an example).

Jim summarizes with a discussion that returns to the topic of controlling the logic in the intactness model. *Jim*: If you believe some of the thresholds in the literature, you can over-ride the model very easily, for example, using well density and its impact on sage grouse. You can put well density at the very top of the logic model and us an *OR* operand. It supersedes everything else. *Jim* shows a map of the Uinta Basin where there are 12 wells per 4 sq km. Much of the Uinta Basin becomes unsuitable for sage grouse. Take home message: as you learn more and have more quantitative indicators, you can insert them into the logic model.

Since it was getting late in the day, we covered an additional four wildlife species more quickly.

Big Horn Sheep

The question with bighorn sheep was to distinguish the desert bighorn distribution from that of Rocky Mountain bighorn. *Steve Madsen* agreed that the polygons appeared to be suitable desert bighorn range, but that some polygons seemed to be missing from southwestern Colorado.

Pronghorn Antelope

Pronghorn is another species that is running into trouble in the Uinta Basin; the status map (pronghorn distribution overlaid by the intactness layer) shows this clearly. They suffer from drought and asthma. *Carmen*: In the Colorado Plateau, we transfer pronghorns from southern areas to northern.

White-tailed Prairie Dog

Jim: The distribution of white-tailed prairie dog was enhanced by extracting distribution polygons from pdfs, paper reports. Some of the sources showed active colonies. *Carmen*: Are you going to talk about data problems in the report? Yes. *Jim*: Prairie dogs thrive on disturbance. Using an intactness layer on prairie dog distribution is different than with a more sensitive species. (The status map shows that prairie dog colonies are all located in the lowest intactness areas.)

He also mentions black-footed ferret introductions. *Seth McClean*: The short answer on ferrets is politics.

Flannelmouth Sucker-Razorback Sucker

Jim shows the distribution of flannelmouth sucker and mentions that there is some overlap with that of the razorback sucker. There is active management and stocking of these species. How do you treat that? Spatially, the map will look the same. You aren't modeling new places to put them, but trying to enhance where they already are or were. *Justin*: It may be helpful to look at historic distribution against the present. The state of Utah updates flannelmouth sucker distribution every year (Roger Wilson). *Justin* also notes that it is easier to review stream section distributions than HUCs.

End Day 1.

Friday, September 23, 2011

Finish Wildlife Species Discussion

MQ D3 Where are potential habitat restoration areas?

Jim opened the day with a discussion on restoration. CBI made the attempt to interpret the restoration management question for individual species, but it was hard to be consistent because each species raised new issues and the results seemed so variable from species to species. One can enhance a species locally, occupy more of their former range, or expand their range. Or the question might be, as it was with mountain lion, do we need to restore a species at all?

Jimi Gragg: Opportunities come and go working across land ownerships. Other partners may come to the table. Like sage grouse now is hot. *Lisa Bryant*: With weed treatments, there are structures and partnerships already in place. *Karl*: BLM doesn't manage wildlife directly. When we wrote the restoration question, I thought we were talking more about habitat, vegetation communities, rather than each individual species. *Jimi Gragg*: If you have your S class maps, you know your areas for restoration. *Lisa*: I could see weighting HUCs that have more federal land ownership. *Jim*: Any other ideas for restoration. *Group*: Riparian! *Verlin*: We are looking at watershed level, landscape level restoration. The REAs will help us with change agent risks and help us find areas to protect. *Curtis Warrick*: It is regardless of land ownership. *Verlin*: Sage grouse and mule deer are both high on the list. *Karl*: Vegetation treatments are something that BLM can actually do. We can't say we're going to restore razorback sucker here.

Biodiversity Sites

MQ D5 What is the location/distribution of terrestrial biodiversity sites?

Jim noted that biodiversity sites are areas on the landscape that others have deemed important. He noted that there are many partial datasets on the topic, but that The Nature Conservancy is the only entity that did a wall to wall map. The map results show generic polygons, but in Data Basin one may zoom in, use the identify tool, and a name and attribute table will appear for each area. *Robin*: Then it looks like we are endorsing TNC. We have that issue with Natural Heritage. This was to get info from other sources. *Verlin* agrees. *Jim*: OK that's easy. We'll just provide all the sources.

Ecological and Cultural Sites

Jim notes that very few of the sites are cultural sites. *Karl* says that he is unsure when this name (ecological and cultural sites) got attached to this particular management question. He says the question is (or should be), what is the location of designated sites? **Dynamac Note**: At the moment, the only management question that applies to both of these topics (biodiversity sites and ecological and cultural sites) is MQ D5 listed above. Suggest that we change MQ D5 to read: What is the location /distribution of terrestrial biodiversity sites and designated sites?

Jim relates the story of producing a national Protected Areas Dataset plus roadless areas and easements datasets. He shows all on Data Basin, first a simple ownership map, the enhanced ownership map and finally special designations as requested by BLM. He notes that some of the designations are stacked because the same piece of land may have multiple designations. *Verlin*: Wilderness areas and wilderness study areas are different. *Jim*: They are differentiated in the datasets. *Karl*: Would you want to see them separated in the report? *Verlin*: Yes, I would also want to change the term *cultural sites*. Jim: I would drop it. Karl: We did in Sonoran. **Resolution**: We dropped the term cultural sites.

Jim: Here's another thing that came up in the Sonoran: some folks at the meeting said, we're doing better than this. We have this or that in our management plans. These results don't reflect anything from

management plans; that is not intended to be in here. *Dennis:* Will we be able to manipulate the data? *Jim*: Yes. *Robin*: For connectivity, I think it is less important to have connections between protected areas than it is between habitat types. *Jim:* You want to see sites intersected with vegetation community data. *Verlin*: The biggest value for that is in the step-down phase. It helps to look at areas for priority restoration. *Doug Havlina*: The terminology is confusing. The term ecological site is a term used for soil sites. *Jim*: I would have called them *protected lands*. *Betsy*: The public would also understand the term protected lands. **Resolution:** Drop term ecological sites.

Soils, Biological Crust, and Forage Management

MQ A1 Where are soils susceptible to wind and water erosion?

MQ A2 Where are sensitive soils (including saline, sodic, gypsiferous, shallow, low water-holding capacity)?

Presented by *Wendy Peterman*, CBI, on the telephone: *Wendy* starts with the process model. She notes that they had to merge SSURGO and STATSGO soil data to create a composite of the two. They extracted a wind erodibility group of soils based on the WEG designations in STATSGO. *Wendy* shows a results map of soils with a high risk of wind erosion.

Wendy and *Lisa Bryant* discuss some of the sensitive soils designations, agreeing that *salty* is not a term that describes carbonates.

Wendy shows ecoregional distributions of four classes of sensitive soils (salty [carbonates], high salinity, shallow, and gypsiferous), detail slides of examples of droughty and hydric soils, and a final results map combining all the classes. *Lisa*: This map is useful. It is generalized, but it gives an overview of soil that will be harder to reclaim or restore. *Wendy*: There are areas that may have multiple limitations. *Lisa*: We could weight them. *Jim*: We can also use a thumbnail or inset map to show the two data sources and the less reliable data.

MQ A4 Where are soils that have potential to have cryptogamic soil crusts?

Wendy: Matt Bowker (with Terry Arundel) sent all of his data for early and late successional crust models. His data points were taken in undisturbed areas. For disturbance for early successional crust, they used road layers. For late successional crust, they used invasive grasses as competitors. *Wendy* showed Matt's predicted distribution of early successional crust that has good coincidence with sensitive soils.

Wendy: Matt did a distribution of species that compose late successional crust and then modeled their potential distribution. *Lisa*: He started with early successional species, added in intermediate and late successional. He expanded this from work done in the Escalante-Grand Staircase region. They extrapolated a lot especially in the north. *Jim*: This is a potential map. When I saw the modeled results overlaid with the intactness layer, I was concerned because it is a model. *Wendy*: Intactness will affect crust more than crust will affect intactness. It is hard to incorporate crust as it is hard for dust on snow. *Lisa:* There hasn't been a lot of success in mapping soil crusts. You could pull up ecological sites and use those. Nice work Wendy; that was a lot of work to put that all together.

Jim: People will assume that the darker colors in the model will have late successional crust on them. He points to areas where intactness is high and crust potential is high. In areas where intactness is low and crust potential is high indicates where crust might have been. It may be useful to identify potential restoration areas.

MQ A6 Where are hotspots producing fugitive dust that may contribute to accelerated snow melt in the Colorado Plateau?

Wendy: I spoke to Jayne Belnap to get sources for dust production areas and extracted disturbance variables from LANDFIRE such as agriculture, mechanical treatment, barren, recently burned, and unpaved roads. *Jim*: It sounds like everything is covered, but it is in time steps and snapshots in time and what can be picked up by satellite. *Lisa*: What about oil and gas. *Wendy*: I didn't incorporate it but I can if you want it in. *Lisa*: Yes, the core of each pad is kept vegetation free. *Brendan* commented on the roads data. The datasets do not distinguish between paved and unpaved roads. They made some decisions on that, but they may not have caught them all. *Wendy*: We did use some aerial photography.

Wendy shows the results map for potential contributing areas of fugitive dust. *Lisa*: There are more higher-resolution attributes that contribute to dust sources and patterns such as prevailing winds, the tunneling effect of winds, saltating sources, and landforms. I can find a citation of Mark Miller's that discusses this. *Karl* recalls Jeff Deems' dust-on-snow presentation at Workshop 3. He notes on the map the two dark areas at the bottom of the map from dust sources on the reservation and their likely contribution to the San Juan Mountains dust deposition areas.

Jim: In general, is this map reasonable? *Lisa*: I am not familiar enough with the area to say yes or no. *Karl*: So Wendy, this is a binary yes or no? *Wendy*: Yes, the data is scored. *Karl*: That might be more useful. *Jim*: We'll get it up on Data Basin. *Verlin*: What about natural features. *Wendy*: This is built on inherent qualities of soil and added disturbance factors. *Jim*: The dataset she will add to Data Basin soon will be able to distinguish that. *Wendy*: A score of 1 for susceptible soil and 2 or higher equals human factors contributing. *Verlin:* It is impossible to show what we are contributing. *Lisa*: Does this results map show both inherent and disturbed? Yes.

Jimi Gragg: There is a temporal component. One can overlay precipitation isolines; higher precipitation areas may be more recoverable. Also it may be clear to keep OHV and grazing out of sensitive soil areas. *Lisa*: Some soils are resistant if they have a gravel component. We can try to figure out that distinction.

Ecological Systems Management Questions

MQ C1 Where are existing vegetative communities?

MQ C3 What change agents have affected existing vegetation communities?

Jim reviewed the discussion about which of the two main landcover datasets, NatureServe (NS) or LANDFIRE (LF), to use. He noted that we had to use LANDFIRE for those questions that concerned a historic reference condition or a departure from reference since there is no other spatial dataset that represents historic condition. *Jim*: We also used LANDFIRE to show historic and recent disturbances. For management questions relating to the current distribution of vegetation communities, we decided to use both data sources and let users choose which one is the most appropriate. You will see examples of comparisons between the two datasets.

<u>Pinyon-Juniper Woodland</u>

<u>Distribution</u>. *Jim* began with pinyon-juniper woodland. Each slide showed the two vegetation data sources side by side. For pinyon-juniper woodland the pattern between the two datasets was similar, but the density was different between the two. NatureServe had split out a pinyon-juniper shrubland and LF had combined the two classes.

To show what change agents have affected pinyon-juniper, *Jim* showed the LF BpS (Biophysical Settings) layer for pinyon-juniper. *Brendan*: When developing BpS, LF considered natural disturbance

regime and site potential. *Doug Havlina*: Was this LF national or LF Refresh? *Brendan:* We tried to get it, but it wasn't ready. *Jim*: Have you seen Refresh? *Doug*: Historic vegetation too closely mirrored present vegetation. Ancient or true pj sites are not represented. There should be a large difference between the two because of encroachment. *Jim*: This is a community that should have some mobility, with variability due to precipitation cycles and fire. *Tom Edwards*: The legacy effects on pinyon-juniper are huge. In Rich County, Tom learned that large areas once covered by pinyon-juniper no longer have it because ranchers took it out. *Jim*: Pinyon decline will add more complexity. *Tom*: Pinyon represents the mean, juniper the variance. *Jim*: We're going to be creating new communities. *Tom*: We're submitting a paper on new hybrid zones.

Recent Disturbance. Jim showed a detail of examples of recent disturbances shown overlaid on historic distribution. This dataset was somewhat limited because it did not cover every conceivable disturbance, but it was the only dataset with full ecoregional coverage. One aspect missing was insect damage. Jim showed a slide of pinyon-juniper mortality 2000–2007. The die-back is partly the result of drought stress and soil type. *Shawn*: It looks suspicious at the state lines. *Jim*: Colorado took more pains to capture the detail. *Tom*: The FIA data shows mortality data in more detail. We thought we'd see step functions, but it is constant. Junipers are much better at extracting moisture, but then too much moisture is also a problem for pinyon because juniper outcompetes.

Historic Change. *Brendan*: For historic change we layered development, agriculture, invasive vegetation, and vegetation change (conversion to other vegetation types) from LANDFIRE. *Karl*: Did you use the same layers that you used for intactness? *Jim:* This is just showing the intersection with pinyon-juniper only. *Doug Havlina*: This doesn't tell the story of succession. Would it be impossible to show a pixel color for succession to pinyon-juniper (the delta between historic and present vegetation)? *Jimi Gragg*: PJ expands in all directions. It seems more efficient to compare BpS and EVT. *Jim*: These datasets represent dominant cover, though there is a lot of nuance. You need higher levels of discrimination at the site level. I would pick one that represents the region best.

Brendan: It wasn't in the management questions, but we could produce a delta layer. *Doug*: I like that idea.

Karl: During the workshop, Ecological Site Descriptions have been mentioned. Would it be useful to have a map of ESDs? *Dennis* thinks that is a great idea. *Steve*: Some have been updated and are more useful. *Jim*: We have to be careful because you think you have the most recent data and you don't.

Big Sagebrush Shrubland

Jim showed a similar series of slides for sagebrush distribution, recent disturbances, and historic change.

Oil and gas is not represented as a recent disturbance. *Betsy*: I think that it would be good to include. *Jimi:* Couldn't you overlay it? *Shawn Servoss*: There are 2 acres per well pad and 13 or 14 per section. That makes a big impact. *Brendan*: Vegetation change is not a delta, but labeled uncharacteristic vegetation. *Jim*: We're trying to relate the disturbances to the vegetation community individually rather than the composite. *Doug*: It doesn't capture succession. That will be shown in the next version? Yes.

Aaron Wilkerson: Wooded shrublands and wooded grasslands might be more susceptible to disturbance. Because of pj manipulation over the last 100 years I would think some of what is called invasion might just be re-establishment.

Mixed Salt Desert Scrub

We moved quickly through the last example of vegetation community distribution and alteration.

Connectivity

Jim: Rather than do connectivity for each species (which is huge), we thought we would do as we did in California (with Paul Beier). We did what was called the "magic marker" version that works for a state level or ecoregion view. We identified large landscape blocks and created a friction surface. We had various size thresholds: in the Sierra they were huge; in the valleys and coast range the polygons were smaller. For the first pass, we created a disturbance surface underneath. We created a node in each patch and ran a model that creates a least cost path from patch to patch. Sometimes it is only a pixel wide. We create a swath around the path that is a standard deviation wide. Then we run circuit theory on top of this. Circuit theory comes from telecommunications to manage interactions. Then we ask, Are any of these connections more important that the others?

Carmen: You are not taking species into account yet? *Jim*: There is an algorithm to prioritize which corridor is more important. This is general for species. We were also sensitive to producing a product of value that didn't duplicate other efforts. *Carmen*: Have you finished it yet? *Jim*: All but the circuit theory part. *Betsy*: The blocks are your intact areas? Yes. *Jim*: California was complex. For example, there were just three areas for movement from the coast range to the Sierra. The Tehachapi area was one of the best remaining areas. The intactness blocks are scored. If we detect a patch that is all invasives, for example, we will toss it out. *Verlin*: You have connectivity areas selected and prioritized. What makes the high priority choice better than the others? *Jim*: Circuit theory does not have the same values as ecological priorities. *Karl:* It must consider size and distance.

Jim shows an example on the flip chart, a system of blocks and connections. *Jim*: If I lose this one, the effects are local; if I lose this one, it disrupts multiple links and how various groups of blocks relate to each other. I think this will work even better at the ecoregional level than at the state level. *Carmen*: You broad brush a connector; putting in a city or a buried pipeline will have different effects on the landscape. *Jim*: It is just aimed to show sensitive areas where caution should be taken in planning. *Tom*: One of the coolest things is even being able to do these kinds of things. Monitoring indicators that could be updated every couple of years. *Verlin*: It is a good example of an ecosystem level view of things. *Karl*: I think this will be important for climate change as well. *Justin Jimenez*: I saw eight different community types, but where is riparian? *Jim*: National mapping efforts are not ideal. We were asked to look at matrix communities. We haven't done patch communities yet. *Betsy*: I second the motion. Wetlands data is poor.

Climate Change

Dominique Bachelet, specialist in climate change adaptation, was on the phone to help present the climate change results.

Jim started with slides showing the climate change workflow:

- Downscale the regional model from 15 km to 4 km
- Use NCEP National Weather Service records and 3 global models to set the boundary conditions
- Select the parameters of interest (e.g., average annual temperature and total precipitation, seasonal temperature and precipitation)
- Compare the boundary condition results with regional historic conditions (based on PRISM 1969–1999)
- Calculate the differences between historic to future time step for each GCM and each parameter.
- De-bias the results by applying the differences to PRISM historic condition
- Feed future model results into Mapped Atmosphere Plant Soil System (MAPSS) to predict future leaf area index, potential evapotranspiration, potential natural vegetation, and runoff.

Dennis: Why does historical only go to 1999? *Jim*: Looking for a historic window, for averages within a window of years. *Karl*: Some people believe we are already experiencing climate change since 2000. To keep it clean, they don't include the year 2000 or after. *Dominique*: We did not choose these periods. We were told these. *Jim*: For any of these we are starting somewhat wetter, trying to account for departure. You want to de-bias the data by changing the reference point. *Dominique*: Hindcasting historical condition is not perfect.

Jim: We also wanted to ask, what is the impact on vegetation? We took it a step further by using MAPSS. This will have more value to resource managers than just the temperature story.

Jim shows a slide comparing PRISM and NCEP historic conditions and states that we are using PRISM as a more realistic regional view of historic weather conditions.

Average Annual Temperature

Jim shows a slide comparing PRISM average annual temperature (1968–1999) with each of the global circulation models (GENMOM, ECHAM5, and GFDL) at the two time steps (2015–2030 and 2045–2060) and another showing the differences from PRISM for each model and time step.

Jim: The models don't agree. Climate change deniers interpret that as "they (climate scientists) don't know what they are talking about." But they are just testing different assumptions. The differences in time spans are not additive; they are just comparing to PRISM.

Jim: You have seen ensemble mapping where the results are averaged. Then you risk losing information. *Dominque*: An average of 2 models that recognize the monsoon (GENMOM and ECHAM5) and one that doesn't (GFDL) would be an odd average.

Average Summer Temperature

Same slide sequence showing PRISM and the differences.

Dominique: Bins for temperature are large because we are looking across a large region. The range is broader than just for the Colorado Plateau. *Jim*: The take-home message for the temperature results is a short term increase, but greater later (second time step), as much as 3° C over the long term.

Average Annual Total Precipitation

Slide showing PRISM and the various models and time steps.

There is more variability among the models with precipitation than with temperature. *Jim*: We see periods of drier conditions and then precipitation increases in the later time frame. *Dominique*: With the first models the 2020s showed hotter and drier with the probability of increased fire. Now we see it again in these models. Some increased moisture mid-century and then less again at the end of the century. It is interesting to look at the full trajectory. Think trajectory rather than just snapshots. *Jim*: We were asked to package this as 15 year average snapshots. Even for 2045–2060, that is wetter over that whole time frame, but we might miss a drought period in those years.

Doug Havlina: Why can't we show a graph year to year? *Jim*: These are averages that have 3 data points. There are other models that show the variability. Those aren't the models we were asked to do. *Dominique*: We have full time series for ECHAM5. If you want to look at a time series of temperature over the whole period, we would show you an animation using NetCDF. *Jim*: You can stack lots of information in one place that way. *Doug*: We correlate fire severity with ENSO patterns. *Dominique*: RegCM3 does an excellent job at tracking ENSO patterns. There is extreme uncertainty what will happen

to ENSO in the future. We don't know the real cause of the shift from one phase to the other. It is difficult to put in a model. We hope it will deal with ENSO.

Average Summer Precipitation

Slide sequence showing PRISM and the differences of various models

Dominique: This slide shows the problems of averaging across various models. Showing an average between GENMOM and ECHAM5 will not give you more information. It is more important to use a range rather than an average. *Karl*: What is our level of confidence between temperature and precipitation? *Dominique*: Our confidence is higher for temperature. Precipitation is all over the place. Local patterns in cloud nuclei, topography, land cover, and ocean interactions: each model has some variability in setting these boundary conditions.

Average Winter Precipitation

The patterns show wetter conditions and a warming climate implying more rain in higher elevations and less snow pack.

Jim: We are not going to ensemble this. We are delivering separate models to show variability. We have to take this into projection space. We are going to pick ECHAM5 to do future projections.

LUNCH

While waiting for the computer to be unlocked, the group turned to a discussion of the outline for the final report. *Karl* presented the original outline draft and a second version offered by Craig Goodwin. The discussion centered on how to optimize readability and utility while at the same time controlling the prodigious quantity of material. *Karl* suggested that much of the material be put into appendices.

Chris Colton: Users want to be able to use it and see it all A to Z. *Carmen*: All the details will be in the appendix. Most readers read the executive summary. *Robin Sell* likes a more systematic presentation. *Carmen* sees the need to present several stories. *Sandy Bryce*: Each region has its top issues that can form case studies for the body of the text. There will be a hierarchy of presentation with the featured stories and then a shorter summary for the rest. *Jim* added that a similar format or template would be used for the summarized elements. Note: We used a template approach for portions of Memo 3.

Tom Edwards described a large report where the maps were converted to map cartoons and reference made to the appendices where the final maps were found. *Jim*: We will need examples for some of the elements found in the appendix such as the logic models. Logic models will have to be explained in the body of the text with an example. *Tom*: Where will the data be archived? *Karl*: The data portal at NOC. *Karen Prentice*: They do want to have the data portal be public. *Karl*: The REAs will prompt sub-assessments for various topical areas or geographic areas in the future.

Karl noted that Chapter VI referred to ecoregional direction or step-down to the sixteen BLM Field Offices. *Verlin*: With the step-down process, we have a way to utilize what comes out of these. Once the REAs are done, they can be used in field work and management planning. **Note**: It has been brought up in earlier discussions that BLM will contribute text to Chapter VI.

Betsy: There is a step-down but also a step-across to the LCCs. LCCs have been issuing RFPs to fund projects. *Karen:* After these REAs are complete, we will set up a regional management team. There are states where BLM has lots of surface ownership, but we produced an REA even in Montana where there is not much surface management. *Robin*: Regional management teams will be concerned with the ecoregions as we know them in these REAs? Yes.

Back to Climate Change

MAPSS Section (Mapped Atmosphere-Plant-Soil System)

Leaf Area Index (LAI)

As before, the first slide is LAI simulated by MAPSS using PRISM historical climate. The next slide shows the change in LAI for the 3 global climate models (GENMOM, ECHAM5, and GFDL) over the two time steps compared to PRISM (1968–1999).

Dominique: MAPSS uses long-term average climate data to determine the amount of water available for vegetation. During the driest month of the year all of the water in the soil profile is used by the vegetation that is there. MAPSS uses minimum winter temperature and other climate variables to distinguish suitable conditions for needleleaf or broadleaf trees for example. The hydrology model looks at the water budget. Leaf Area Index is higher at higher elevations.

Potential Evapotranspiration

Dominique: A decrease in evapotranspiration indicates that conditions are wetter.

The models show drier and warmer conditions particularly in the earlier time period (2015–2030).

Runoff

The models show an increase in runoff. Increased runoff means less water uptake by plants.

Potential Vegetation

Dominique: The model is extremely sensitive to the water budget. Vapor pressure is very important to represent water demand. Don't take this image of potential vegetation as a final value. We want to make sure it is interpreted properly. Open canopy means a lower LAI. Shrub in this model is a small tree and grasses are considered as a proportion of C3/C4 grasses.

Jim explains that the plant communities are global functional communities. We have to try to fit our local vegetation into those general categories. Also, this is potential vegetation that would be present if humans were not. *Karl*: They are going to do a cross-walk in the report. *Chris*: It shows semi-desert and it is already desert? *Dominique*: Bulk density, soil depth, and texture are considered for each pixel. *Lisa:* What drives desert and semi-desert is salinity. It will also drive soil moisture. *Dominique*: This is run at 4 km using STATSGO and calibrated with Küchler and runoff.

They show a slide of a table of vegetation changes. When PRISM was compared with the 2045–2060 time step, shrub savanna evergreen lost 30,000 pixels. There is also a large increase in short C4 grasses that do better in warmer conditions.

Uncertainty (contribution by Miguel Fernandez and Healy Hamilton)

Dominique: The estimation of the intensity of uncertainty is unitless. The first two images on the slide show uncertainty estimates for interannual variability in temperature and precipitation between 1968 and 1999. There are separate maps for each because all weather stations do not give both temperature and precipitation. There are also separate maps showing a representativity index for both temperature and precipitation and one for vertical and horizontal distance.

Dominique: Climate modelers like flat areas and areas that have little difference in temperature. Temperatures in the mountains are related to inversion patterns so weather stations don't help. We have

difficulties where the terrain is more complex. *Karl*: We have relatively high uncertainty because of rugged terrain and lack of weather stations. Can we combine these maps? *Dominique*: Yes, the plan is to combine these 5 maps into an index to use as an uncertainty layer. *Jim*: Will this be in time for our report? *Dominique*: Not before the end of the year. These layers can give an uncertainty value. The representativity maps are mostly blue indicating high uncertainty. The different results between GENMOM and ECHAM5 are within the realm of possibility because of what we know about variability. *Jim*: How do you interpret the legend? Do we worry about any blue at all or just the dark blue areas? *Dominique*: Take a map for species models. Overlay these uncertainty maps and if an area is in dark blue, I would not have confidence. I would trust more in the green areas. I would put more resources in the green areas. Looking at interannual variability, if variability increases, plants used to stable climate conditions will be more stressed than those adapted to variable climate. *Karl:* Looking at the three categories. They relate to weather stations. Is it because we are using PRISM as a baseline? Yes.

Tom and *Betsy* point out that the first two variability maps are the most useful and that people will want to see the variability among the 3 climate models. *Dominique*: We can provide maps like those for all the future models. *Jim*: I think additional variability maps will be of value. Do we have numbers on how the mins and maxes (minimum and maximum mean temperature) work through time?

Verlin: Question on vegetation mapping based on potential vegetation, say with sage grouse, sagebrush habitat. How will we know that existing vegetation will change? *Jim*: This will tell us where there is a major vegetation shift. It may be more difficult to manage in its current condition. You may try but it may be a losing battle as the vegetation moves to another state. *Karl*: We did it yesterday: we overlaid intactness with sage grouse distribution. Then we can add fire regime and ECHAM5 climate model. *Jim*: It is complicated, but there is enough information to be used in multiple ways. *Verlin*: We are going to use this information almost immediately; we will need to have an understanding of how to use it. *Jim*: We ran it for much of the west, not just this ecoregion.

Concluding Remarks

Tom Edwards: Is there any other way to provide comments? *Jim*: We set up Data Basin for extensive comments, but for overarching comments, there is always email.

Karl: We want to work on an aquatic integrity model with Justin. *Jim*: We will get a webinar together on the aquatic integrity piece. Let's shoot for next Friday.

PLEASE Sign In

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Name	Affiliation	Email	Phone
Stephanie Gwin	Dynamac	sgwin@dynamac.com	541-829-9693
Sandy Bryce	Dynamac	sbryce@dynamac.com	541-752-2711
Mel Miller	USGS	mamiller@usgs.gov	435-259-3866
Betsy Herrmann	USFWS	betsy_herrmann@fws.gov	801-975-3330
Jimi Gragg	Utah Div. Wildlife	jimigragg@utah.gov	801-538-4713
Karl Ford	BLM-NOC	kford@blm.gov	303-236-6622
Curtis Warrick	BLM-USO	C Warrick@BLM.GOV	801-539-4072
Chris Colton	BLM-Richfield	ccolton@blm.gov	435-896-15[illegible]
Dennis Zachman	BLM-CO. State Office	dzachman@blm.gov	303-239-3669
Carmen Bailey	Utah. DW of Wildlife	carmenbailey@utah.gov	801-538-4751
Robin Sell	BLM-COSO	rsell@blm.gov	303-239-3723
Steve Madsen	BLM-UTSO	smadsen@blm.gov	801-539-4058
Verlin Smith	BLM UTSO	vlsmith@blm.gov	801-539-4055
J. Bradley Washa	BLM. UTSO	bwasha@blm.gov	801.539.4276
Jeremy Sisneros	BLM UTSO	jsisnero@blm.gov	801-539-4064
Doug Havlina	BLM NIFC	dhavlina@blm.gov	208-387-5061
Shawn Servoss	BLM NOC	sservoss@blm	303 236 6320
Justin Jimenez	BLM UTSO	jjimenez@blm.gov	801-539-407[illegible]
Bruce Sillitoe	BLM SLFO	bsillitoe@blm.gov	801-977-4342
Mike Stiewig	BLM-VFO	[illegible]	435-781-4400
Lisa Bryant	BLM-UTSO	lmbryant@blm.gov	801 539-4069
Wayne Padgett	BLM-UTSO	wpadgett@blm.gov	801-539-4076
Alan Bass	BLM-UTSO	abass@blm.gov	801-539-4149
Karen Prentice	BLM-WO200	kprentic@blm.gov	202-912-723[illegible]
~~JERRY~~ SEMPEK	BLM-UTSO	jsempek@blm.gov	801-539-408[illegible]
John Bradford	USGS-SBSC	jbradford@usgs.gov	928-380-467[illegible]
Tim Miller	BLM-NOC	tmiller@BLM.gov	